O. **NORTH FORK OF GROUSE CREEK**
(tributary to Grouse Creek)

Waterbody Type:	Stream
Ecoregion:	Northern Rockies (HUC #17010214053210)
Designated Uses:	none, existing uses are agricultural and domestic water supply, cold water biota, and primary and secondary contact recreation.
Size of Waterbody:	7.3 miles long
Size of Watershed:	9,856 acres (USFS database); 10,805 acres (IDL database)

Summary: The North Fork of Grouse Creek problem assessment concluded that the stream is impaired due to excess sediment. A target load of 684.4 tons/yr was developed based upon historical land use. To achieve the target load a reduction of 1,687.4 tons/yr of sediment is required for the watershed.

1. Physical and Biological Characteristics

[Refer to the Grouse Creek problem assessment for general physical characteristics of the entire watershed.]

The upper 4 miles (54%) of the North Fork of Grouse Creek is owned by the state and W-I Forest Products. This area remained mostly unroaded until the mid-1970s. Much of the riparian areas of the lower North Fork are in private ownership either by individual homeowners or by W-I Forest Products.

2. Pollutant Source Inventory

Point Source
There are no permitted point source discharges in the North Fork of Grouse Creek.

Nonpoint Source
The primary pollutant, sediment, was the result of various nonpoint source activities conducted over the last thirty years. Unlike other portions of the watershed, the North Fork of Grouse Creek was not logged in the 1920s and in 1934 less than 5% of the drainage had been cleared for homesteading. However, in the last 30 years the USFS, the State and W-I Forest Products have all had timber sales in the drainage. The USFS harvested timber on the Sand Ridge side in the early 1960s. In the 1970s, timber harvesting continued further north to Sand Mountain and into the Dyree Creek drainage. In the mid-1970s, a relatively large timber sale was conducted in parts of the North Fork of Grouse and BRC watersheds. In the early 1990s, overstory trees were removed from previously harvested stands on Sand Ridge. The upper four miles of the North Fork remained unroaded until about the mid 1970s.

As a result of this timber sale activity, haul roads became a source of large amounts of bedload due to mass wasting problems. This bedload caused the stream to alter channel type to a more braided form below Dyree Creek. Further downstream the braided channel returns to a single thread channel, but is aggrading with 88% of the streambed moving downstream. Again, this indicates recent sources of dis-equilibrium that have not yet either stabilized or fully worked their way downstream.

At BRC Creek, the North Fork is also moving bedload through the system, although the channel type is representative of a less impacted form. Data collected by the USFS in 1989 thru 1992 shows the effect on the stream of the excess bedload movement through this reach. By 1992 the channel had become wider, had split late season flows and began undercutting the right bank. The outlook of this situation was that if bedload forces continue undercutting the bank, riparian vegetation will not be able to hold the bank together. The right bank will fail and the stream will become shallower and wider at this spot. Trends of equilibrium for Grouse Creek and North Fork of Grouse Creek are conceptually displayed in Figure 1.

2.a. Summary of Past and Present Pollution Control Efforts

All restoration measures recommended for the North Fork Grouse by the Grouse Creek Environmental Assessment were implemented by the U.S. Forest Service.

3. Water Quality Concerns and Status

Nutrients and sediment were identified as primary pollutants of the tributaries to the Pack River by DEQ in 1989 (Idaho Department of Health and Welfare, 1989). In 1996 the North Fork of Grouse Creek was determined to be water quality impaired due to sediment pollution and placed on the 1996 list of impaired waters. After the listing, DEQ assessed the support status of the stream using data collected in 1996 from the beneficial use reconnaissance project. The conclusion of this assessment, utilizing the process outlined in the 1996 Waterbody Assessment Guidance, was that the lower portion of the North Fork does not support all of its beneficial uses. Scores for the various parameters measured in the lower and upper reaches were macroinvertibrate biotic index scores of 2.02 and 3.89 and habitat index scores of 107 and 113, respectively. Salmonid spawning was not assessed in the North Fork of Grouse Creek.

3.a. Applicable Water Quality Standards

Idaho's water quality standard for sediment is narrative, and states that, "Sediment shall not exceed quantities ...which impair designated beneficial uses. The North Fork of Grouse Creek does not have designated uses and therefore, existing uses will be protected. Existing uses include agricultural and domestic water supply (USDA, 1993), cold water biota, salmonid spawning, and primary and secondary contact recreation (mean monthly peak flow of 111 cfs).

3.b. Summary and Analysis of Existing Water Quality Data

Two models were used to aid in the USFS's analysis of the Grouse Creek watershed (USDA, 1993). The WATSED model (USDA, no date) was used to approximate sediment delivery and water yield for each drainage. The "Rain-On-Snow" model developed by Kappesser (1991) evaluates the risk of increasing peak flows from rain-on-snow events. These models simplify, for analysis, extremely complex physical systems and are developed from a limited data base. Stream flow data used in the models had been recorded by the USFS for the North Fork of

Grouse Creek since 1985.

Results from these analyses quantify the relative differences between natural and existing conditions. Table 1 shows the expected natural mean monthly peak flows and routed sediment amounts versus the existing mean monthly flows and existing routed sediment. Routed sediment amounts are twice that expected under natural conditions.

Past water quality sampling is limited to USFS data and included total suspended sediment and turbidity taken at the North Fork of Grouse Creek gauge site. Data indicates that In 1975, 1979 and 1980 there were high sediment flushes. The highest recorded sediment movement was over 68,000 tons per day and occurred in 1975. Over eight miles of road were constructed in the North Fork drainage at that time. Turbidity was high during that time period also, reaching a high of 28 JTUs in 1975 (1 JTU=1 NTU). Background turbidity levels were very low (<5 JTU).

Watershed improvement needs were identified by the USFS during the summers of 1991 and 1992. For the North Fork of Grouse Creek these include the following:

* Increase woody debris in Dyree Creek in order to control the streambed gradient and reduce bedload inputs to the North Fork.

* Road #215 in Section 4 on the east bank of the North Fork has chronic mass wasting . Obliteration of an existing skid road and restoration of the road prism to natural contours would eliminate the problem of concentrating road surface runoff onto areas susceptible to landslides.

* The lower reaches of the North Fork would benefit from cedar plantings to help re-establish river banks and provide a source of large woody debris.

* Approximately one mile upstream from the confluence with Grouse Creek, an old road exists which should be permanently closed and revegetated to prevent its erosion during flood events.

The Beneficial Use Reconnaissance 1996 data was used to determine support status using the 1996 Waterbody Assessment Guidance process. The macrobiotic invertebrate index score for the lower sample site was 2.02 and the habitat index score was 107 indicating that the cold water biota use is impaired and the stream requires a TMDL. No fish data was collected by the Reconnaissance project.

The Cumulative Watershed Effects results for sediment delivery in the North Fork of Grouse Creek watershed was rated moderate. The temperature rating was high, indicating that site specific best management practices are required to address this problem.

3.c. Data Gaps For Determination of Support Status

Salmonid spawning was not assessed using DEQ's 1996 Waterbody Assessment Guidance.

4. Problem Assessment Conclusions

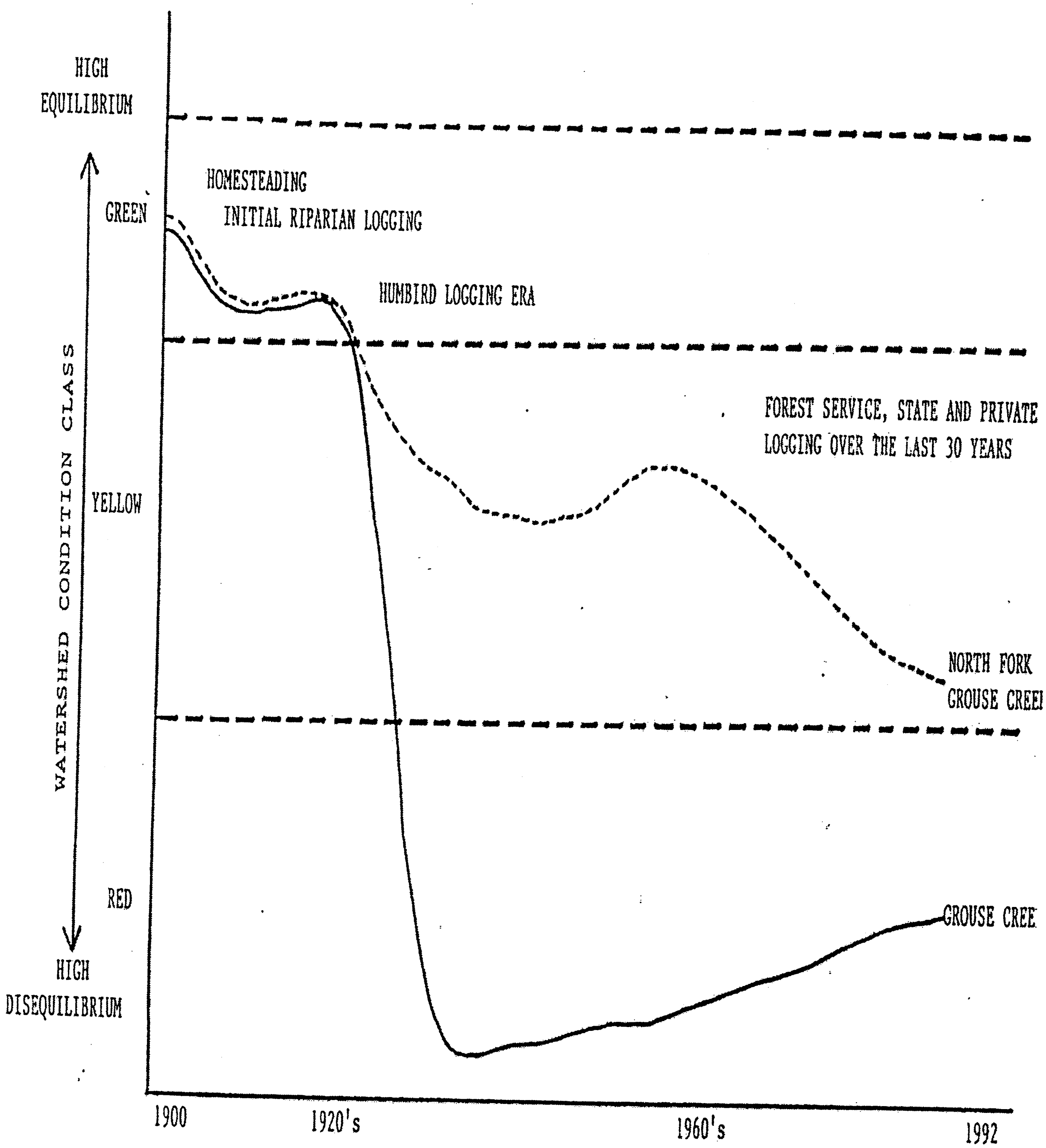
Table 1.

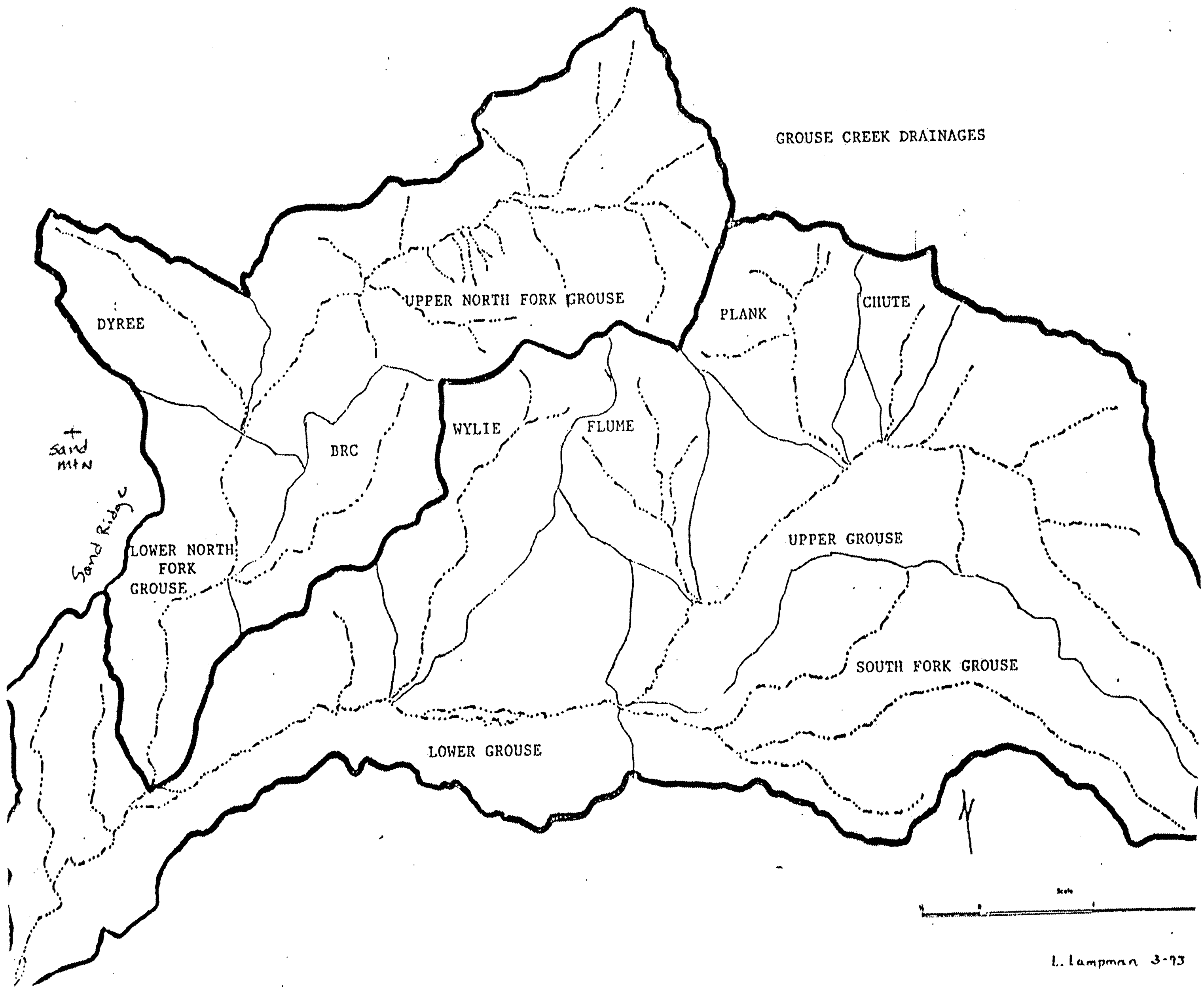
NATURAL AND EXISTING SEDIMENT AND WATER YIELD PER SUBDRAINAGE

NAME OF DRAINAGE	WATSED NATURAL MEAN MONTHLY PEAK FLOW (cfs)	WATSED EXISTING MEAN MONTHLY PEAK FLOW (cfs)	% INCREASE IN EXISTING OVER NATURAL	WATSED NATURAL ROUTED SEDIMENT (tons/sq mi)	WATSED EXISTING ROUTED SEDIMENT (tons/sq mi)	% INCREASE IN EXISTING OVER NATURAL	EXISTING RAIN ON SNOW RISK RATING
SOUTH FORK GROUSE	36.5	36.9	1	25.3	28.3	12	1.01
WYLIE	16.1	16.7	4	35.0	46.9	34	1.06
CHUTE	4.9	5.1	5	48.2	48.2	0	1.17
PLANK	12.5	13.1	5	29.1	29.1	0	1.29
UPPER NORTH FORK	38.1	38.5	1	24.6	36.7	49	1.06
DYREE	6.6	7.1	8	30.1	96.9	222	1.25
BRC	10.9	11.2	3	31.9	65.7	106	1.24
FLUME	10.4	10.7	3	36.1	40.1	11	1.00
ALL NORTH FORK	70.3	73.1	4	21.5	42.6	98	1.22
UPPER GROUSE	80.1	82.5	3	23.1	27.0	17	1.15
ALL GROUSE	246.0	253.4	3	18.1	26.1	44	1.15

Figure 1.

CONCEPTUAL EQUILIBRIUM TRENDS SINCE 1900




GROUSE CREEK DRAINAGES
DYREE
UPPER NORTH FORK GROUSE
PLANK
CHUTE
BRC
WYLIE
FLUME
LOWER NORTH FORK GROUSE
UPPER GROUSE
SOUTH FORK GROUSE
LOWER GROUSE
Sand Mtn
Sand Ridge
N
Scale
L. Lampman 3-93

Based upon DEQ's assessment, cold water biota is a use not fully supported in the North Fork of Grouse Creek. Excess bedload, channel dis-equilibrium and a lack of large woody debris are the major limiting factors to achieving full support. A reduction of sediment entering the stream, a re-establishment of large woody vegetation along the channel and time for the existing bedload in the stream to move through the system are elements required to achieve full support status for the North Fork of Grouse Creek. Primary pollutant sources are roads.

5. TMDL

Two methods were used to calculate the sediment load reduction required for the North Fork. The first TMDL is based upon information obtained from the USFS Grouse Creek Environmental Assessment (USDA, 1993). The resulting target loads and load reductions are presented in tons per square miles, however, they can also be presented as tons/mi²/yr. It was emphasized that these values are relative, not actual load amounts. Error for this analysis is approximately 100% (personal communication Hefner 1999). The second analysis is based primarily upon Cumulative Watershed Effects analysis data and other information. To be consistent with the rest of the basin TMDLs, method 2 will be used to calculate target loads and load reductions. Method 1 is shown for comparison purposes only.

Method 1

5.a. Numeric Targets

Based on the USFS analysis (USDA, 1993) natural background sediment loads in the North Fork of Grouse Creek are:

Tributary	Area (mi²)	X	Bckgrnd Erosion Rate (t/mi²/yr)	=	Bckgrnd Load (t/yr)
Lower North Fork	3.0	X	21.5	=	64.5
North Fork Above Dyree Creek	8.4	X	24.6	=	206.6
Dyree Creek	1.9	X	30.1	=	57.21
BRC Creek	2.1	X	31.9	=	67.0
TOTAL					**395.3**

5.b. Source Analysis

Based on the USFS analysis (USDA, 1993) existing sediment loads for the North Fork of Grouse Creek are:

Tributary	Area (mi²)	X	Existing Erosion Rate (t/mi²/yr)	= Existing Load (t/yr)
Lower North Fork	3.0	X	42.6	127.8
North Fork Above Dyree Creek	8.4	X	36.7	308.3
Dyree Creek	1.9	X	96.9	184.1
BRC Creek	2.1	X	65.7	138.0
Total				**758.2**

5.c. Linkage Analysis

The cause of stream channel disequilibrium and the presence of excess bedload in the channel can be assessed by measuring certain parameters of the stream. The largest particle size commonly moved by the stream and the particle size distribution of the streambed on a riffle (Wolman Pebble count) were used to develop the Riffle Armor Stability Index (RASI) (Kappesser, 1992) values for the North Fork. The values obtained by this analysis are represented by the "D" number, which is simply the percentile of the streambed particle sizes commonly moved by the stream (see Table 2).

Table 2. Riffle Armor Stability Index Values For the North Fork of Grouse Creek.

Stream	Largest Particle Size Transported	RASI Value
North Fork		
above FS road #215	179mm	D66 (equilibrium)
above Dyree Creek	179mm	D82 (?)
below Dyree Creek	N/A	N/A (braided channel-total disequilibrium)
above BRC Creek	108mm	D88 (aggrading)
below BRC Creek	123mm	D82 (aggrading)
gauge station	110mm	D71 (aggrading)
Dyree Creek	111mm	D81 (aggrading)
BRC Creek	138mm	D44 (equilibrium)

These data indicate that sections of streambed are moving abnormally large amounts of cobble size and smaller sediment downstream, disrupting beneficial uses of cold water biota and salmonid spawning. Actively eroding slopes and banks in this watershed should be repaired to stop the supply of bedload to the streams.

To determine how much sediment is still entering the system, two additional models were used.

WATSED (USDA no date) estimates current sediment delivery and water yield, and the "Rain on Snow" model (Kappensser 1991) evaluates the risk of increasing peak flows from rain-on-snow events. Neither model provides an absolute measure against verifiable standards. However, they do provide a numerical means of comparing one stream with another or one stream over time. Repetition of all three models can demonstrate change in the pollutant load entering the stream and the location of excess bedload still present in the system. Studies have shown that WATSED typically under-estimates mean monthly peaks by 34%, as evidenced by comparing actual flow at the North Fork gauge station with predicted flows. Flows shown in Table 1 are model generated and have not been adjusted to more accurately reflect actual flows. Increasing the flow by 34% did not affect the model values for sediment delivery.

5.d. Allocations

The WATSED analysis indicates that a reduction of 362.9 tons/yr is required for the North Fork of Grouse Creek, of which 101.7 tons/yr of reduction should come from the North Fork above Dyree Creek. Dyree Creek requires a reduction of 126.9 tons/yr, the Lower North Fork 63.9 tons/yr, and BRC Creek a reduction of 71.0 tons/yr.

5.c. and 5.e. Monitoring Plan for Method 1 and Monitoring Plan and Linkage Analysis for Method 2

Because Idaho's Water Quality Standard for sediment is narrative and not based upon something directly measurable in the water column, a different approach is required to achieve a satisfactory monitoring plan. An analysis of the methods available for monitoring the success of TMDLs indicates that, in this case, more than one method should be used to verify the cause of the impairment, track load reduction, and to show that the stream is moving towards full support. The sediment monitoring plan will include three parts:

1. Determination of support status using Beneficial Use Reconnaissance monitoring. If the conclusion of the survey is no impairment for two surveys taken within a five year time period then the stream can be considered restored to full support status.

2. Load reduction measures shall be tracked and quantified. For example, 1.2 miles of road obliteration near a stream, 0.5 miles of stream bank fenced, 5 acres of reforestation, etc.

3. Amount of sediment reduction achieved by implementation of load reduction measures shall be tracked on a yearly basis. For example, 1.2 miles of road obliteration will result in a 6 tons/yr reduction, 0.5 miles of stream bank fenced will result in a 3 ton/yr reduction, 5 acres of reforestation will result in a 0.7 ton/yr reduction, etc.

The reason for this three part approach is the following:

1. DEQ presently uses the Beneficial Use Reconnaissance data to indicate if the stream is biologically impaired. Often times this impairment is based upon only

one Reconnaissance survey. The survey should be repeated to insure that the impairment conclusion is correct and repeated twice after implementation to determine if the (improved) support status conclusion is correct. Survey data may show an impairment in fisheries or macroinvertebrates and the cause of the impairment may point to sediment pollution. However, there is not a direct linkage between the pollutant and the impairment. Sediment could be indicated as the problem when, in fact, temperature might be the problem. The Reconnaissance data is not specific as to the cause, just that there is a problem. So using the Reconnaissance data alone to monitor the TMDL is not adequate.

2. There is great uncertainty about how much sediment actually needs to be reduced before beneficial uses are restored. These TMDLs use a very conservative approach, in that the sediment target is limited to natural background amounts. However, beneficial uses may be fully supported at some point before this target is achieved. Therefore, a measure of sediment reduction cannot be used exclusively to determine a return to full support.

3. Because TMDLs are based upon target loads measured in a mass per unit time there must be a method included to directly measure load reductions. Coefficients which estimate sedimentation rates over time based upon land use have been used to develop the existing loads. This same method can be used for land where erosion has been reduced. Road erosion rates are based upon the Cumulative Watershed Effects road scores. These scores can be updated as road improvements are made and the corresponding load reduction calculated.

Method 2
See attached spreadsheet.

5.f. Margin of Safety

Method 1

The load reduction estimated by WATSED (362.9 tons/yr) is 4.6 times smaller than the load reduction predicted by Method 2 (1,687.4 tons/yr). The percent error of the WATSED model is approximately +-100% of actual loads. The WATSED model does not provide an absolute measure against verifiable standards, however, it does provide a numerical means of comparing one stream with another or over time. Because of the error associated with the WATSED estimate, assigning a margin of safety would just increase the error of the method. Use of natural background as a target is the most conservative approach available and requires no margin of safety.

Method 2

Because the measure of sediment entering a stream throughout the entire watershed is a difficult and inexact science, assigning an arbitrary margin of safety would just add more error to the analysis. Instead, all assumptions made in the model have been the most conservative available. In this way, a margin of error was built into each step of the analysis. For an explanation of how the Cumulative Watershed Effects data was collected and processed, refer to the Idaho Department of Lands manual titled, "Forest Practices Cumulative Watershed Effects Process For Idaho". One important detail to note when looking at how the Cumulative Effects data was used in the TMDL is that, although all forest roads in the watershed were not assessed, the field crews are directed to assess the roads most likely to be contributing sediment to the stream. This weighted the average road scores towards the ones most likely to be in poor condition. Natural background is used as the target load which is the most conservative assumption available.

References

Dechert, T., Raiha, D. And Saunders, V. 1999. Grouse Creek Cumulative Watershed Effects Assessment. September. Idaho Department of Lands. Coeur d'Alene, Idaho.

Hefner, Ken. 1999. Personal communication by telephone November 22. USDA Forest Service, Ogden Utah.

Kappesser, G. 1991. A procedure for evaluating risk of increasing peak flows from rain on snow events by creating openings in the forest canopy. USDA - Forest Service. Idaho Panhandle National Forests, Coeur d'Alene, Idaho.

McGreer, D.J., Sugden, K. Doughty, J. Metzler, G. Watson. 1997. LeClerc Creek Watershed Assessment. Lewiston, Idaho.

Stevenson, Terril K. 1996. Correspondence to Shelly Gilmore, Cocolalla Lake SAWQP Project Coordinator from Terril Stevenson, USDA-NRCS Geologist, Idaho State Office. Geology, Erosion and Sedimentation Report. January 30, 1996.

Stevenson, Terril K. 1999. Correspondence to Mark Hogan, Soil Conservation Commission Coeur d□Alene from Terri Stevenson, USDA-NRCS Geologist, Idaho State Office. December 2.

USDA Forest Service. No date. WATSED. Water and Sediment Yields. Region 1, Forest Service and Montana Cumulative Watershed Effects Cooperative.

USDA Forest Service. 1993. Grouse Creek Environmental Assessment. Idaho Panhandle National Forest. Sandpoint Ranger District.

North Fork Grouse Creek: Land Use Information

Land Use		**Explanation/Comments**
Sub-watershed	N. Fork Grouse	
Pasture (ac)	**8**	
Forest Land (ac)	**9529**	
Unstocked Forest (ac)	**1268**	Includes once burned areas
Highway (ac)	0	State or County Paved Highways
Double Fires (ac)	0	Areas which have been burned over twice

Road Data		
Sub-Watershed	N.Fork Grouse	
1. Forest roads (total miles)	**55**	
CWE road score (av)	29.6	
*Sediment export coefficient (tons/mi/yr)	**10.2**	
#Total Forest Rd Failures (cubic yds delivered)	**628**	*Cumulative Watershed Effects Data*
##2. Unpaved Co.& priv. roads (total miles)	5.2	
Paved Co.&priv. roads (total miles)	0	
Total C&P Rd Failures (cubic yds delivered)	59.4	*Based on weighted average of forest road failures.*
###Stream bank erosion-both banks (mi)		***erosion coefficients*
poor condition	**1.9**	*95 tons/yr/mi*
good condition	**7.3**	*47.5 tons/yr/mi*

*McGreer et al. 1997
**Stevenson 1999. Good Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.1 ft/yr X 1ton/2000lbs = 47.5 tons/yr/mi
Poor Condition: 5,280' X 2' high bank X 90lbs/ft3 X 0.2 ft/yr X 1ton/2000lbs = 95 tons/yr/mi
#Total road failures are the amount of sediment observed by the CWE crews that was delivered to the stream. This amount is used to represent the yearly delivery to the stream. This is an over-estimate of sediment delivered to the stream since failures can continue to deliver sediment to the stream for a number of years after they occur, however, in a much reduced quantity. One must also take into consideration that all failures were not observed, which is an under-estimate of delivered sediment. These two factors combined with on-site verification by a

largest failures which probably occurred during the floods of 1996.
##County and private road erosion derived from using the same method as forest roads. Since the method used for foest roads is not designed for non-forest roads, the calculations will be revised if a better method can be found using the existing information.
###Source of data from 1996 aerial photos.

North Fork Grouse Creek: Sediment Yield

Sediment Yield From Land Use		Explanation/Comments
Watershed:	N.F.Grouse	*Acres by Land Use X Sediment Yield Coefficient = Tons Sediment/yr* *Yield Coeff. (tons/ac/yr)*
Pasture (tons/yr)	1.1	*0.14*
Forest Land (tons/yr)	362.1	*0.038*
Unstocked Forest (tons/yr)	21.6	*0.017 (this acreage is a subset of Forest Land acreage)*
Highway (tons/yr)	0	*0.034*
Double Fires (tons/yr)	0	*0.017 (this acreage is a subset of Forest Land acreage)*
Total Yield (tons/yr)	**384.8**	*(Values taken from WATSED and RUSLE models see below explanation [#])*

*Sediment Yield From Roads		
Watershed:	NF Grouse	
Forest Roads (tons/yr)	**561.0**	*Miles Forest Rd X Sediment Yield Coeff. from McGreer Model*
Forest Road Failure (tons/yr)	**898.7**	***Assumes soil density of 1.7 g/cc and a conversion factor of 1.431.*
County and Private Roads (tons/yr)	53	
Co. and Private Road Failure (tons/yr)	85	

*Percent fines and percent cobble of the Pend Oreille - Treble series B&C soil horizons is 80% fines, 20% cobble (Bonner Co. Soil Survey).
**"Guide for Interpreting Engineering Uses of Soils" USDA, Soil Conservation Service. Nov. 1971.
#Land use sediment yield coefficients sources: Pasture (0.14) obtained from RUSLE with the following inputs: Erosivity based on precipitation; soil erodibility based on soils in the watershed; average slope length and steepness by watershed; plant cover of a 10 yr pasture/hay rotation with intense harvesting and grazing; and no support practices in place to minimize erosion.
Forest Land (0.038) obtained from WATSED with the following inputs: landtype and size of watershed
Unstocked Forest (0.017) obtained from WATSED with the following inputs: Acreage of openings, landtype and years since harvest.
Highways (0.034) obtained from WATSED with the following inputs: Value obtained from the Coeur d'Alene Basin calculations.
Double Fires (0.017) obtained from WATSED with the following inputs: Acreage, years since fire and landtype.

North Fork Grouse Creek Watershed: Sediment Exported To Stream

	NF Grouse Watershed
Land use export (tons/yr)	384.8
Road export (tons/yr)	561.0
Road failure (tons/yr)	898.7
Bank export (tons/yr)	
poor condition	180.5
good condition	346.8
Total export (tons/yr)	**2371.8**
*Natural Background Mass Failure (tons/yr)	322

*Background mass failure is the difference between the total mass failure observed in the watershed, and the mass failure associated with roads.

North Fork Grouse Creek Watershed

	Acres	Yield Coefficient (tons/ac/yr)		Background Load (tons/yr)
Total Watershed	9537			
Presently Forested	9529			
Estimated Historically Forested	9537	0.038		362.4
Estimated Historically Pasture	0	0.14		0
*Natural Mass Failure (tons/yr)				322
Background Load = Target Load			**Target Load**	**684.4**
			Existing Load	**2371.8**
			Load Reduction	**1687.4**